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Habitual Physical Activity After Total Knee Replacement

Roel F.M.R. Kersten, Martin Stevens, Jos J.A.M. van Raay, Sjoerd K. Bulstra, Inge van den Akker-Scheek

Background. Previous studies on physical activity after total knee arthroplasty (TKA) concentrated mainly on a return to sports activities.

Objective. The objectives of this study were to determine the habitual physical activity behavior of people who had undergone TKA (TKA group) 1 to 5 years after surgery and to examine to what extent they adhered to international guidelines for health-enhancing physical activity. Additional aims were to compare younger (<65 years old) and older (≥ 65 years old) people as well as men and women in the TKA group and to compare the results for the TKA group with those for a sex- and age-matched normative population (normative group).

Design. This investigation was a cohort study.

Methods. All people who had a primary TKA at 1 of 2 participating hospitals between 2002 and 2006 were sent the Short Questionnaire to Assess Health-Enhancing Physical Activity at least 1 year after surgery.

Results. The TKA group spent, on average, 1,347 minutes per week on physical activity, most of which was light-intensity activity (780 minutes per week). Participants younger than 65 years of age spent significantly more time on physical activity than participants 65 years of age or older. There was no significant difference between male and female participants. Compared with the sex- and age-matched normative group, the TKA group spent significantly less time on the total amount of physical activity per week and met the guidelines for health-enhancing physical activity less often (55% versus 64%).

Limitations. A self-administered questionnaire was used to assess habitual physical activity, and presurgery data on physical activity were not available.

Conclusions. Almost half of the TKA group did not meet the health-enhancing physical activity guidelines, and the TKA group was not as physically active as the normative group. People who have undergone TKA should be encouraged to be more physically active.

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Osteoarthritis of the knee is one of the most prevalent age-related chronic conditions. It causes significant impairment in people's ability to perform activities of daily living and has a marked impact on quality of life.¹ In addition, inactivity-associated medical costs for adults with osteoarthritis are substantial.² In cases of advanced osteoarthritis, total knee arthroplasty (TKA) has emerged as a highly successful treatment. With the aging of the population, the percentage of people 55 years of age or older will rise sharply; for example, in the Netherlands it is expected to rise from 26% in 2005 to 35% in 2025.³ This trend will increase the number of people with age-related chronic diseases such as osteoarthritis. Total knee arthroplasty has a positive impact on the quality of life through pain relief and enhanced physical function and restores people's ability to perform physical activities.⁴

Physical activity has been proven to prevent several chronic diseases, improve fitness, and decrease mortality.^{5,6} For older adults, staying physically active is of utmost importance. Being sufficiently physically active prolongs functional independence, resulting in a higher quality of life. Moreover, a physically active lifestyle improves muscular strength, balance, and coordination and therefore decreases the risk of falling.^{7,8} Decreasing the risk of falling is even more important after knee arthroplasty because a fall can result in complications with the implanted knee prosthesis, such as fractures and deboning. Finally, for people

who are overweight, physical activity can result in weight loss, which has a positive impact on the survival of the prosthesis.⁹

Because of the beneficial effects of physical activity, international guidelines have been developed for levels of health-enhancing physical activity. These guidelines recommend 30 minutes or more of moderate-intensity aerobic (endurance) physical activity at least 5 days per week or vigorous-intensity aerobic physical activity for a minimum of 20 minutes at least 3 days per week.^{10,11} Wagenmakers et al¹² showed that patients who had undergone total hip arthroplasty (THA) did not differ from people in a normative population with regard to the amount of physical activity; only half of the patients who had undergone THA and half of the people in the normative population met the physical activity guidelines. However, the amount of habitual physical activity after TKA is unknown. Previous studies on physical activity after TKA concentrated mainly on a return to sports activities.¹³⁻¹⁵ Also, it is unknown to what extent patients who have undergone TKA meet the guidelines for health-enhancing physical activity.

The aims of this study were to determine the habitual physical activity behavior of people who had undergone TKA at 1 to 5 years after surgery and to examine to what extent they adhered to international guidelines for health-enhancing physical activity. Additionally, we studied the physical activity behavior of people who had undergone TKA in 2 age groups and of men and women separately. Finally, the physical activity behavior of people who had undergone TKA was compared with that of people in a sex- and age-matched normative population.

Method

Participants and Procedure

This study included all patients who had undergone primary TKA at the University Medical Center Groningen and at Martini Hospital Groningen, both in Groningen, the Netherlands, between October 2002 and October 2006. In accordance with usual practice, patients had received physical therapy from day 2 after surgery until discharge from the hospital. Physical therapy consisted of mobilization of the knee and exercise relating to major activities of daily living, such as walking with aids and walking on stairs. Full weight bearing was allowed from day 2 on. After discharge, patients were referred to an outpatient physical therapist for further treatment. Patients were excluded if they had dementia, had poor eyesight, could not read the Dutch language, recently had undergone a second joint replacement, or were currently admitted to the hospital. Before enrollment in this study, patients had to have a recovery period of at least 1 year. In October 2007, a questionnaire and an explanatory letter were sent to 1,320 potential participants, who were informed that return of the questionnaire would be considered consent to participate.

The normative population consisted of people from the same geographic region as the study population. Data were collected in 2006 by the Municipal Public Health Service Groningen, Groningen, the Netherlands, as part of population screening. Participants who had undergone TKA (TKA group) were matched to people of the same sex and age, within a range of 6 years, in the normative population. None of the people in the normative population were diagnosed with osteoarthritis or rheumatoid arthritis.

Questionnaire

The Short Questionnaire to Assess Health-Enhancing Physical Activity

Editor's Note

- A [Correction](#) to this article was published in the August 2012 issue of *PTJ* on page 1079.

(SQUASH) was used to determine the amount of habitual physical activity.¹⁶ Participants were asked to report what kind of physical activities they performed during the preceding week, the number of days per week they performed these activities, and the average time per day they spent performing these activities. The activities were clustered in 4 categories: commuting activities, activities at work or school, household activities, and leisure-time activities (including sports activities). All activities were assigned a metabolic equivalent (MET) value on the basis of the compendium of physical activities of Ainsworth and colleagues.^{17,18} In this system, a MET value of 1 is associated with the energy expenditure of sitting (1 MET=3.5 mL O₂·kg⁻¹·min⁻¹); MET values of greater than 1 are defined as multiples of the resting metabolic rate. Activities are grouped in 3 intensity categories: light, medium, and high intensities. For adults who are 54 years of age or younger, activities with MET values of 2 to less than 4 are classified as light intensity, activities with MET values of 4 to less than 6.5 are classified as medium intensity, and activities with MET values of 6.5 or greater are classified as high intensity. For adults who are 55 years of age or older, activities with MET values of 2 to less than 3 are classified as light intensity, activities with MET values of 3 to less than 5 are classified as medium intensity, and activities with MET values of 5 or greater are classified as high intensity. Activities with MET values of less than 2 are not included because of the low metabolic rate of those activities.

With the reported data, the total amount of physical activity per week and the amounts of physical activity per week for each intensity category and for each activity category could be calculated. The amount of time spent on each particular activity also

could be calculated; in this study, only walking and cycling were included because these activities were frequently performed by participants in the TKA group. Furthermore, it could be determined whether Dutch and international guidelines for health-enhancing physical activity were met. Participants who spent 30 minutes or more on medium-intensity or high-intensity physical activity at least 5 days per week were considered to have met these guidelines.

The SQUASH has been tested for validity and reliability with an accelerometer as a criterion measure in a general adult population and in an older adult population after primary THA.^{16,19} In addition to the SQUASH, participants were asked to provide demographic information (age, sex, and body mass index).

Data Analysis

Statistical analyses were performed with Statistical Package for the Social Sciences software (SPSS 18.0, SPSS Inc, Chicago, Illinois). To describe the main characteristics of the research population, descriptive statistics were used. For participants in the TKA group, Mann-Whitney *U* tests were used to compare the amounts of physical activity for men and women and for participants who were younger than 65 years of age and 65 years of age or older (65 years is the average age of retirement for people in the Netherlands). Furthermore, Mann-Whitney *U* tests were used to compare participants in the TKA group with people in the matched normative group. These analyses were used for the total amount of physical activity and for the amounts of physical activity for each intensity category, each activity category, walking, and cycling. Chi-square tests were used to compare the percentages of people in the groups fulfilling health-enhancing physical activity guidelines. A *P*

value of less than or equal to .05 was considered statistically significant.

Results

The questionnaire was sent to 1,320 potential participants; 844 returned the questionnaire, for a response rate of 64%. Fourteen questionnaires were excluded because they were incomplete. Thus, the questionnaires from 830 participants who had undergone primary TKA were included in the analyses. Most participants in the TKA group were women (*n*=615, 74.1%), and the mean age at the time of the study was 72.0 years (SD=9.3). The mean body mass index of participants in the TKA group was 29.4 kg/m² (SD=5.0). The characteristics of the people who did not return the questionnaire were comparable to those of the study participants (79.6% women; mean age at time of study=74.4 years [SD=11.9]).

An overview of the habitual physical activity in minutes per week for participants in the TKA group is shown in Table 1. Participants in the TKA group spent, on average, 1,347 minutes per week on physical activity. Most of the time was spent on light-intensity activity, followed by medium- and high-intensity activities. With regard to activity categories, participants in the TKA group spent most of the time on household and leisure-time activities. About half of the participants in the TKA group met the health-enhancing physical activity guidelines (50.8%). The mean time since surgery was 3.0 years (SD=1.2). The distribution of participants over time since surgery (5 groups) and the average total amount of physical activity of participants in the 5 groups are shown in Table 2. The amounts of physical activity in the 5 groups were different (Kruskal-Wallis test, *P*=.02); a decline was seen over time (years since surgery). *Post hoc* analyses revealed that the difference between

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Table 1.

Physical Activity Behavior of 830 Participants With Total Knee Arthroplasty

Physical Activity	\bar{X} (SD) (min/wk)
Average total amount	1,347 (1,278)
Intensity categories	
Light	780 (874)
Medium	337 (577)
High	223 (374)
Activity categories	
Activities to and from work	33 (185)
Activities at work	134 (497)
Household activities	715 (794)
Leisure-time activities	465 (663)
Sports activities	52 (140)
Walking	167 (335)
Cycling	122 (242)
% of participants meeting guidelines ^a	50.8

^a International guidelines for health-enhancing physical activity.

the 1-year postsurgery group and the 5-year postsurgery group was statistically significant (Mann-Whitney *U* test with Bonferroni correction for multiple testing, $P = .003$).

To assess the potential influence of sex and age on patterns of physical activity, we performed subanalyses for participants in the TKA group. Table 3 shows the results of a comparison of participants who were younger than 65 years old with participants who were 65 years of age or older. Overall, participants who were younger than 65 years spent significantly more time on physical

activity. This difference was seen in all intensity and activity categories and for cycling but not walking. Participants who were younger than 65 years met the guidelines for health-enhancing physical activity more often than participants who were 65 years of age or older.

We also performed a subanalysis of the influence of sex on the physical activity of participants in the TKA group (Tab. 4). Although men spent more time on physical activity than women overall, this difference was not statistically significant. With regard to the intensity of physical

activity, men spent significantly more time on medium- and high-intensity activities, whereas women spent significantly more time on light-intensity activities. Men spent significantly more time on activities to and from work, activities at work, and leisure-time activities. On the other hand, women spent significantly more time on household activities. There was a significant difference in cycling, with men spending more time. Moreover, men met the guidelines for health-enhancing physical activity significantly more often than women.

Of the 830 participants in the TKA group, 675 could be sex and age matched to people in the normative group. Therefore, comparisons of the TKA group with the normative group were made for these 675 participants and their controls.

In both groups, 460 of the 675 participants or controls were women. The mean age of the participants in the TKA group was 70.1 years (SD=9.2); that of people in the normative group was 69.6 years (SD=9.0). Participants in the TKA group showed, on average, significantly less physical activity (1,433 minutes per week) than people in the normative group (1,532 minutes per week) (Tab. 5). With regard to intensity categories, both groups spent most of the time on light-intensity activities. The normative group spent significantly more time on medium- and high-intensity activities. With regard to activity categories, the normative group spent significantly more time on all 4 activity categories. Sixty-four percent of the normative group met the guidelines for health-enhancing physical activity; this percentage was significantly higher than that for the TKA group.

Discussion

The aim of the present study was to determine the habitual physical

Table 2.

Time Since Surgery and Corresponding Physical Activity Levels in 830 Participants With Total Knee Arthroplasty (TKA)

Years Since Surgery	No. (%) of Participants in TKA Group	\bar{X} (SD) (min/wk) of Average Total Amount of Physical Activity
1	76 (9)	1,636 (1,374)
2	254 (31)	1,362 (1,188)
3	199 (24)	1,437 (1,422)
4	176 (21)	1,266 (1,179)
5	125 (15)	1,110 (1,252)

activity behavior of people with TKA 1 to 5 years after surgery. The results showed that participants who had undergone TKA spent, on average, 1,347 minutes per week on physical activity at 3 years after surgery; most of this time was spent on light-intensity activities and on household and leisure-time activities. A decline in the amount of physical activity over time since surgery was seen. Because almost 50% of participants in the TKA group did not meet the guidelines for health-enhancing physical activity, people who have undergone TKA should be encouraged to be (more) physically active. Being male and being younger than 65 years of age increased the chance of meeting the guidelines. Compared with people in the sex- and age-matched normative group, participants in the TKA group had a significantly lower total physical activity level and met the Dutch and international guidelines for health-enhancing physical activity significantly less often.

The strengths of the present study were a response rate of 64%, a large research population, and a sex- and age-matched normative population for comparison. However, there also were some limitations. We used a self-administered questionnaire, the SQUASH, to assess the amount of habitual physical activity. Although the reliability and validity of this questionnaire have been demonstrated, there are limitations to the use of questionnaires to assess physical activity. For example, people tend to overestimate their physical activity level when using subjective measures rather than objective measures.²⁰⁻²² A solution for this problem would be to use a more objective measure, such as accelerometers; however, this approach does not allow measurement of the physical activity behavior of a large population. Our comparison of the physical activity behaviors of the

Table 3. Physical Activity Behavior in 2 Age Groups of Participants With Total Knee Arthroplasty

Physical Activity	\bar{X} (SD) (min/wk) of Physical Activity in Participants Who Were:		P ^a
	<65 Years of Age (n=191)	≥65 Years of Age (n=639)	
Average total amount	1,995 (1,520)	1,153 (1,127)	<.001
Intensity categories			
Light	1,149 (1,100)	669 (761)	<.001
Medium	540 (748)	277 (500)	<.001
High	281 (407)	205 (362)	<.001
Activity categories			
Activities to and from work	823 (1,274)	18 (146)	<.001
Activities at work	458 (818)	37 (284)	<.001
Household activities	875 (898)	668 (755)	<.001
Leisure-time activities	580 (628)	430 (670)	<.001
Sports activities	85 (192)	42 (119)	<.001
Walking	173 (253)	166 (356)	.06
Cycling	157 (286)	111 (226)	<.001
% of participants meeting guidelines ^b	61.8	47.6	.01

^a P values of ≤.05 indicated a statistically significant difference.
^b International guidelines for health-enhancing physical activity.

Table 4. Influence of Sex on Physical Activity of Participants With Total Knee Arthroplasty

Physical Activity	\bar{X} (SD) (min/wk) of Physical Activity in Participants Who Were:		P ^a
	Men (n=215)	Women (n=615)	
Average total amount	1,486 (1,429)	1,289 (1,218)	.19
Intensity categories			
Light	561 (897)	856 (854)	<.001
Medium	563 (808)	259 (445)	<.001
High	348 (492)	179 (311)	<.001
Activity categories			
Activities to and from work	68 (274)	21 (140)	<.001
Activities at work	317 (766)	70 (336)	<.001
Household activities	324 (529)	852 (826)	<.001
Leisure-time activities	778 (969)	355 (469)	<.001
Sports activities	67 (185)	46 (120)	.38
Walking	223 (473)	148 (268)	.33
Cycling	182 (312)	100 (208)	<.001
% of participants meeting guidelines ^b	67.4	45.0	<.001

^a P values of ≤.05 indicated a statistically significant difference.
^b International guidelines for health-enhancing physical activity.

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Table 5.

Physical Activity Behaviors of Participants With Total Knee Arthroplasty (TKA) and People in the Normative Group

Physical Activity	\bar{X} (SD) (min/wk) of Physical Activity in the Following Groups:		P ^a
	TKA (n=675)	Normative (n=675)	
Average total amount	1,433 (1,313)	1,533 (1,325)	.05
Intensity categories			
Light	803 (897)	785 (787)	.20
Medium	372 (600)	445 (702)	<.001
High	250 (393)	294 (430)	.02
Activity categories			
Activities to and from work	37 (188)	57 (277)	<.001
Activities at work	160 (534)	162 (510)	.04
Household activities	724 (814)	757 (764)	.05
Leisure-time activities	513 (695)	581 (727)	<.001
Sports activities	55 (138)	71 (235)	.41
Walking	176 (328)	163 (351)	.60
Cycling	135 (254)	141 (276)	.63
% of participants meeting guidelines ^b	54.5	63.7	.01

^a P values of $\leq .05$ indicated a statistically significant difference.

^b International guidelines for health-enhancing physical activity.

TKA group and the normative group was probably not compromised by this issue because the same (subjective) measure was used with both groups, although it is possible that after surgery people overestimate their physical activity level even more as a result of the reduction in pain.²² Another limitation was the fact that presurgery data on the amount of habitual physical activity of participants in the TKA group were not available.

To our knowledge, this is the first study of the habitual physical activity behavior of people who have undergone TKA. Research on physical activity after TKA has focused mainly on whether people return to sports activities. Therefore, a comparison of our results with the results of other studies was problematic. Wagenmakers et al¹² conducted a similar study on the habitual physical activity of patients after THA and compared the results with those for

people in a normative population. They showed that 51.2% of patients who had undergone THA met the guidelines for health-enhancing physical activity; in the present study, 55% of people who had undergone TKA met these guidelines. These findings suggested no difference between THA and TKA. However, patients who had undergone THA spent a total of 1,601 minutes per week on physical activity; in the present study, people who had undergone TKA spent 1,347 minutes per week on physical activity. The difference could be attributed to the amounts of light-intensity activities (1,003 minutes per week for people with THA and 780 minutes per week for people with TKA). The fact that the average age of people who had undergone THA was 62.7 years and the average age of people who had undergone TKA was 72.0 years could explain the difference; in the present study as well as in previous

studies, a younger age was correlated with a higher activity level.^{12,15}

Previous studies showed that, on average, women have a lower activity level than men after TKA.^{15,23} Although our findings indeed showed that men spent more time on physical activity than women overall, this difference was not significant ($P=.19$). When we examined the physical activity behavior of participants in the TKA group in more detail, we found a difference between men and women in the amounts of time spent in different intensity categories; women in the TKA group spent significantly more time on light-intensity activities, whereas a significant difference in favor of men in the TKA group was seen for moderate- and high-intensity activities. These findings stress the importance of determining physical activity behavior in more detail, especially in patients after joint arthroplasty, because the intensity of activities is one of the factors considered to be related to prosthetic wear.²⁴

With regard to time spent in leisure-time activities—in particular, walking and cycling, which are favorite activities in the Netherlands—participants in the TKA group spent the same amounts as people in the normative group. Because a return to sports and leisure-time activities is an important expectation of patients, our findings can be a guideline that clinicians can use to inform patients about regaining function after TKA. A remarkable finding was the fact that participants in the TKA group spent significantly less time on activities to and from work. It is possible that before surgery, participants in the TKA group adjusted their lifestyle to their pain and limitations, including ways to go to and from work. The fact that participants in the TKA group were used to these transportation methods may explain

their behavior regarding activities to and from work after surgery.

After TKA, surgeons generally encourage their patients to participate in nonimpact or low-impact sports and not to participate in high-impact sports or high-intensity activities^{25,26} to keep peak impact on the knee as low as possible. High-impact peak forces are associated with more wear of the prosthesis, which can lead to the need for revision of the prosthetic knee.²⁴ The present study showed that participants who had undergone TKA indeed spent less time on medium- and high-intensity activities than people in the normative population. Further research should focus on the exact association between the amount and the intensity of physical activity on the one hand and prosthetic wear on the other.

The finding that almost half of the participants who had undergone TKA did not meet the health-enhancing physical activity guidelines is disturbing. Fewer than 50% of the women who had undergone TKA and participants who had undergone TKA and were 65 years old or older fulfilled the guidelines. Moreover, as years passed since the time of surgery, people appeared to become less physically active. This finding has implications for clinical practice. People in general should be encouraged to be more physically active. A higher level of physical activity is associated with several health-enhancing benefits. However, because several benefits are especially important for people who have undergone TKA—such as better bone quality, enhancement of coordination and muscle strength and, consequently, a lower risk of falls⁷⁻⁹—people who have undergone TKA should be encouraged even more to become (more) physically active. Although physical therapists frequently have contact with

people who have undergone TKA immediately after surgery, our findings suggest that the duration of physical therapy is inadequate with respect to longer-term physical activity levels. A longer follow-up of people who have undergone TKA seems appropriate to identify people with high-risk profiles and declining physical activity levels, to inform these people about the importance of being physically active, and to guide them to become (more) physically active. Future research should focus on the effectiveness of various long-term postsurgery interventions that physical therapists can use to encourage a physically active lifestyle.

Dr Stevens and Dr van den Akker-Scheek provided concept/idea/research design and project management. Dr Kersten and Dr van den Akker-Scheek provided writing, data collection, and data analysis. Dr van Raay and Dr Bulstra provided participants. Dr Stevens, Dr van Raay, and Dr Bulstra provided facilities/equipment and consultation (including review of manuscript before submission).

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Kersten RF, Stevens M, van Raay JJAM, et al. Habitual physical activity after total knee replacement: analysis in 830 patients and comparison with a sex- and age-matched normative population. *Phys Ther*. doi: 10.2522/ptj.20110273.

On May 24, 2012, “Habitual Physical Activity After Total Knee Replacement: Analysis in 830 Patients and Comparison With a Sex- and Age-Matched Normative Population” by Kersten RF, Stevens M, van Raay JJAM, et al¹ was published online ahead of print in *Physical Therapy (PTJ)*. In the June 2012 issue of *Journal of Physiotherapy*, “After Total Knee Arthroplasty, Many People Are Not Active Enough to Maintain Their Health and Fitness: An Observational Study” by Groen J-W, Stevens M, Kersten RFMR, et al² was published. These two related articles, both of which reported on the same sample of subjects, were written and published each without recognizing the other.

The first article aims to report the habitual physical activity behavior of patients with total knee arthroplasty and provides detailed data on number of minutes of activity per week spent in total, on different intensity categories, on different activity categories, and on separate activities (walking and cycling). These data were reported for male and female patients separately and for different age categories. Moreover, these data were compared with a normative group. The second article focuses on the adherence to different health and fitness guidelines and which factors contribute to these. Although two different research questions are addressed in both articles, it is relevant for the reader to know that these two papers are related. We regret omitting this information from our articles.

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- 2 Groen J-W, Stevens M, Kersten RFMR, et al. After total knee arthroplasty, many people are not active enough to maintain their health and fitness: an observational study. *Journal of Physiotherapy*. 2012;58:113–116.

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Niemeijer AS, Reinders-Messelink HA, Disseldorp LM, et al. Feasibility, reliability, and agreement of the WeeFIM instrument in Dutch children with burns. *Phys Ther*. 2012;92:958–966.

In the July 2012 article by Niemeijer et al titled “Feasibility, Reliability, and Agreement of the WeeFIM Instrument in Dutch Children With Burns,” the equation for calculation of minimal or least detectable difference (LDD) was presented incorrectly in the “Method” and “Results” sections as $\sqrt{2} \times 1.96 \times SEM$ rather than $\sqrt{2} \times 1.96 \times SEM$. The statements, with corrected equation, in those sections should be:

Taking .05 as the significance level, the LDD equaled $\sqrt{2} \times 1.96 \times SEM$.

The LDD on the total score between 2 raters was $\sqrt{2} \times 1.96 \times 3.7=10.3$ points.

The Journal regrets the errors.

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